

MINISTRY OF EDUCATION, SINGAPORE
in collaboration with
UNIVERSITY OF CAMBRIDGE LOCAL EXAMINATIONS SYNDICATE
General Certificate of Education Ordinary Level

CANDIDATE
NAME

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CENTRE
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INDEX
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Paper 3 Chemistry

October/November 2014

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, index number and name on all the work you hand in.
You may use an HB pencil for any diagrams, graphs, tables or rough working.
Write in dark blue or black pen.
Do not use staples, paper clips, glue or correction fluid.

The use of an approved scientific calculator is expected, where appropriate.
You may lose marks if you do not show your working or if you do not use appropriate units.
DO NOT WRITE IN ANY BARCODES.

Section A

Answer **all** questions.

Write your answers in the spaces provided on the question paper.

Section B

Answer any **two** questions.

Write your answers in the spaces provided on the question paper.

At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [] at the end of each question or part question.

Section A

Answer **all** the questions in the spaces provided.

- 1 The properties of a substance make it suitable for particular tasks. Complete Table 1.1 by naming a suitable substance for each of the tasks shown.

Table 1.1

task	substance needed
repairing road surfaces	
lowering the acidity of soil	
fermenting glucose solution	

[3]

- 2 Iron is extracted by heating iron ore with limestone and coke in a blast furnace.

(a) Name an ore of iron.

..... [1]

(b) Write a balanced chemical equation for the

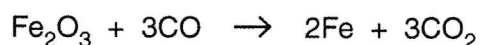
(i) decomposition of limestone,

..... [2]

(ii) production of carbon monoxide in the blast furnace.

..... [2]

(c) Using the equation



state which substance is reduced and give a reason for your answer.

substance reduced

reason

..... [2]

3 Explain why

- (a) carelessly discarding plastics can result in **long-term** pollution,
.....
..... [1]
- (b) not recycling metals can cause problems for **future** generations,
.....
..... [1]
- (c) the **incomplete** combustion of carbon-containing fuels can be dangerous to people,
.....
..... [1]
- (d) the **combustion** of fossil fuels can eventually damage buildings.
.....
..... [1]

4 Many years ago, when grouping the known elements into a Periodic Table, Dmitri Mendeleev predicted that some elements had still to be discovered.

He gave one missing element the name 'eka-aluminium' and the symbol Ea. This element has since been discovered.

The element's electronic structure has four electron shells.

The outer shell contains three electrons.

Use this information to complete Table 4.1.

Table 4.1

information about element	
name of element	eka-aluminium
Mendeleev's symbol	Ea
group of the Periodic Table	
period of the Periodic Table	
charge on each ion	
formula of its oxide	

[4]

5 Fig. 5.1 describes some of the properties and reactions of two solutions, **E** and **F**.

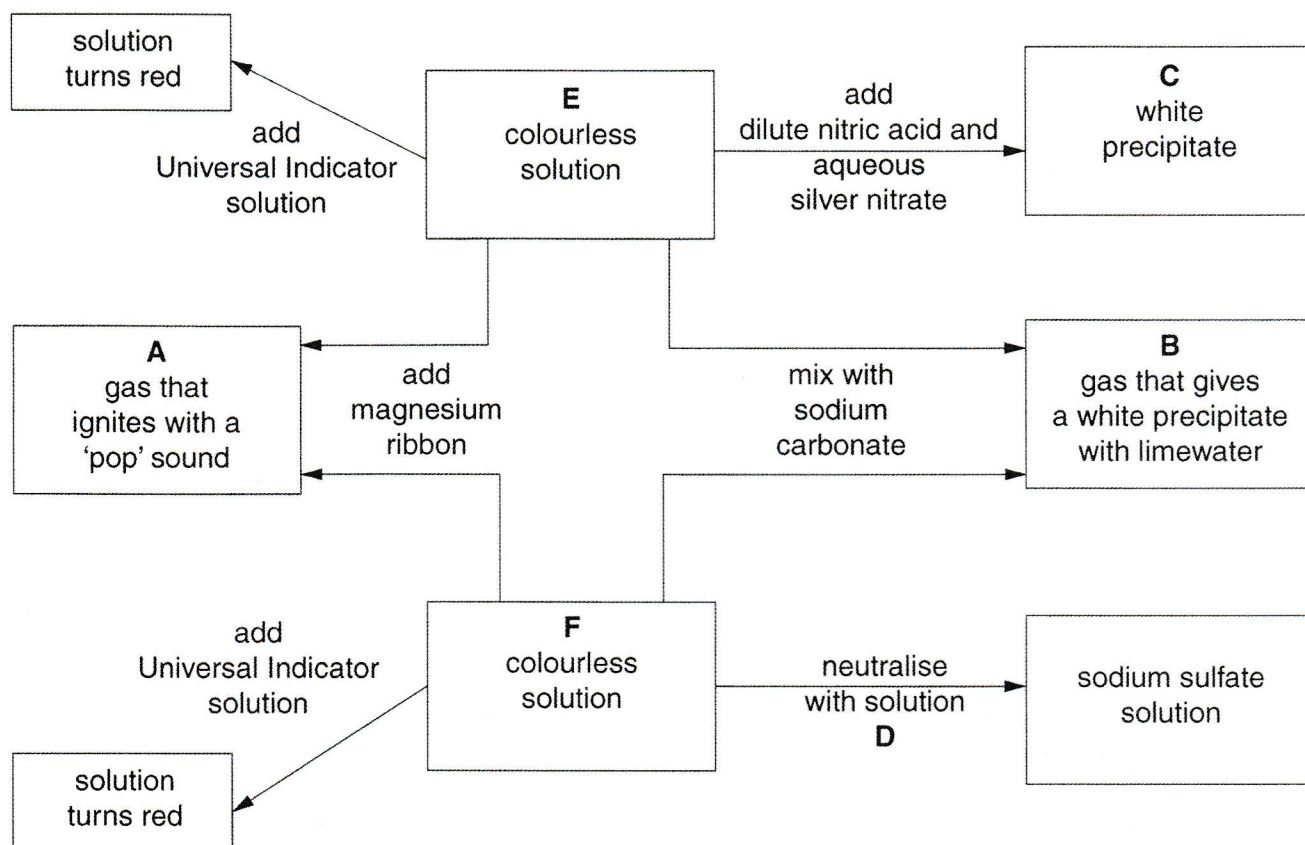


Fig. 5.1

(a) Name **A**, **B**, **C**, **D**, **E** and **F**.

A

B

C

D

E

F

[6]

(b) Write a balanced chemical equation for any **one** of the reactions that are described within Fig. 5.1.

..... [2]

- 6 (a) The alkenes form a homologous series.

State the general formula of this homologous series.

..... [1]

- (b) One alkene contains three carbon atoms in its molecule.

Draw the full structural formula of this alkene.

[1]

- (c) Members of a homologous series show a gradation in physical properties with an increase in molecular size.

- (i) How does the boiling point of an alkene with three carbon atoms in each molecule compare with the boiling point of an alkene with two carbon atoms?

..... [1]

- (ii) Suggest a possible explanation for this difference.

.....
..... [2]

- (d) (i) Which **two** compounds are formed when an alkene burns in excess air?

..... and [2]

- (ii) Write the balanced chemical equation for burning, in excess air, the alkene with two carbon atoms in each molecule.

..... [2]

- 7 (a) Two samples of a copper ore have been discovered. They contain different amounts of copper(II) carbonate but no other carbonate.

When excess dilute acid is mixed with the powdered ore, a gas is produced. The volume of gas formed is a measure of the amount of copper(II) carbonate in the ore.

- (i) Design and describe an experiment that compares the amounts of copper(II) carbonate in the two different ores. You may include a diagram if it helps you to answer the question.

.....

.....

.....

.....

.....

..... [4]

- (ii) Describe the measures you would take to ensure that your experiment is fair.

.....

.....

.....

..... [2]

(b) (i) A solution contains a copper(II) compound.

Describe the chemical test and state the result that is used to show that this solution contains copper(II) ions.

test

.....

result

..... [2]

(ii) Give the **ionic** equation for this test.

..... [2]

Section B

Answer any **two** questions in this section.

Write your answers in the spaces provided.

- 8 (a) Sodium oxide is classified as a basic oxide and carbon dioxide is classified as an acidic oxide. Name two other types of oxide.

.....
..... [2]

- (b) (i) Draw and label the electronic structures of carbon dioxide and sodium oxide.

[Atomic numbers: C, 6; O, 8; Na, 11]

[4]

- (ii) Use these structures to explain why, at room temperature and pressure, sodium oxide is a solid and carbon dioxide is a gas.

.....
.....
.....
.....
.....
..... [4]

- 9 (a) Two metals, **G** and **H**, have similar physical properties. Give **two** of these properties.
-
- [2]
- (b) Explain why metal **H** reacts faster with water when
- (i) the water is hot,
-
-
-
- (ii) the metal is powdered.
-
-
- [4]
- (c) Explain why
- (i) metal **G** will **not** react with water no matter how hot the water is, or how finely powdered the metal,
-
-
- (ii) more energy is needed to extract metal **H** from its compounds than is needed to extract metal **G**.
-
- [2]
- (d) Suggest possible identities for metals **G** and **H**.
-
- [2]

10 (a) Define the term *relative atomic mass*.

.....

.....

..... [2]

(b) Not all of the atoms of nitrogen are identical. All nitrogen atoms have the same chemical properties but they can have different masses.

(i) What name is given to different atoms of the same element?

..... [1]

(ii) Explain why different atoms of nitrogen can have different masses but have the same chemical properties.

.....

.....

.....

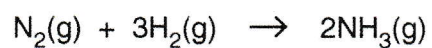
.....

..... [2]

(c) Draw a diagram to show the electronic structure of a nitrogen atom.

[1]

- (d) Nitrogen combines with hydrogen to form ammonia.



[Relative atomic masses: A_r : H, 1; N, 14]

[The volume of one mole of any gas is 24 dm^3 at room temperature and pressure.]

- (i) Calculate the mass of ammonia that can be formed from 56 g of nitrogen.

[2]

- (ii) Calculate the volume that this mass of ammonia has at room temperature and pressure.

[2]

Section A

task	substance needed
repairing road surfaces	bitumen
lowering the acidity of soil	calcium oxide/calcium hydroxide
fermenting glucose solution	yeast

2. (a) haematite
 (b) (i) $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$
 (ii) $\text{CO}_2 + \text{C} \rightarrow 2\text{CO}$
 (c) substance reduced: Fe
 reason: The oxidation state of Fe decreases from +3 (in Fe_2O_3) to 0 (in Fe), showing that Fe is reduced.

EXAM TIP:

When the oxidation state of a substance decreases after the reaction, the substance is reduced.

3. (a) Plastics are non-biodegradable, which means that they cannot be broken down easily in nature and that they will remain in the environment for a long time.
 (b) More metal will have to be extracted from metal ores, which are finite resources. Continual extraction from metal ores will eventually deplete the supply of metal ores.
 (c) Incomplete combustion of carbon-containing fuels produces carbon monoxide, which binds strongly to haemoglobin. This prevents the red blood cells from carrying oxygen efficiently to cells in the body, leading to fatigue or even death.
 (d) Combustion of fossil fuels releases sulfur dioxide or nitrogen oxides, which dissolve in rain water, forming acid rain. Acid rain corrodes limestone or metal structures on buildings.

information about element	
name of element	eka-aluminium
Mendeleev's symbol	Ea
group of the Periodic Table	III
period of the Periodic Table	4
charge on each ion	3+
formula of its oxide	Ea_2O_3

EXAM TIP:

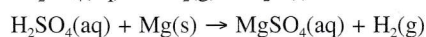
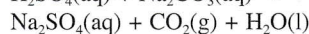
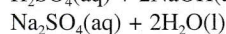
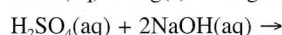
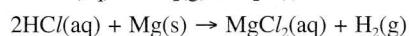
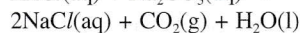
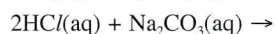
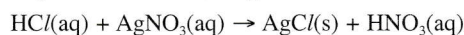
The number of electrons in the outer shell indicates the group of the Periodic Table. The number of electron shells in an atom of an element that is occupied with electrons indicates the period of the Periodic Table.

5. (a) A hydrogen
 B carbon dioxide
 C silver chloride
 D sodium hydroxide
 E hydrochloric acid
 F sulfuric acid

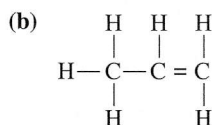
EXAM TIP:

The Universal Indicator solution is used to identify the nature of the solution; aqueous silver nitrate is used to identify the anion; magnesium is added to the test result to identify the reactivity of the metal ion (cation); sodium carbonate is added to the test result to identify the nature of the salt solution.

- (b) Any one of the following:



6. (a) C_nH_{2n}

**EXAM TIP:**

An alkene containing three carbon atoms in its molecule has a formula C_3H_6 .

- (c) (i) The boiling point of the alkene with three carbon atoms is higher than the boiling point of the alkene with two carbon atoms.

EXAM TIP:

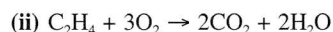
As the number of carbon atoms of an alkene increases, its boiling point increases.

- (ii) Intermolecular forces of attraction become stronger with an increase in molecular size, hence the forces of attraction between molecules are stronger in propene (3-carbon alkene) than in ethene (2-carbon alkene). As a result, more heat is needed to break these forces of attraction for boiling to occur.

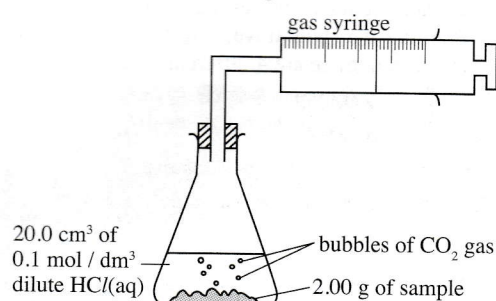
- (d) (i) carbon dioxide and water

EXAM TIP:

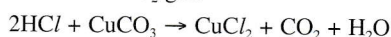
Carbon dioxide and water are formed when an alkene burns in excess air.



7. (a) (i) Weigh out exactly 2.00 g of one of the samples and place it in a conical flask. Add 20.0 cm³ of 0.1 mol / dm³ hydrochloric acid into the flask and quickly cover the flask with a stopper attached to a gas syringe as shown in the diagram below.



At this point, the powdered ore will react with dilute hydrochloric acid to produce bubbles of CO₂ gas.



The reaction is complete once the bubbling stops. Take note of the volume of CO₂ collected in the gas syringe and calculate the number of moles of CO₂ produced. From the equation, CO₂ ≡ CuCO₃, so we can find the number of moles of CuCO₃ present in 2.00 g of ore. Find the percentage of CuCO₃ in the ore using the following formula:

$$\frac{\text{mass of CuCO}_3}{\text{mass of ore}} \times 100\%.$$

Follow the measurements and steps as mentioned to find the percentage of CuCO₃ in the other sample.

EXAM TIP:

The amount of copper(II) carbonate can be determined by measuring the volume of gas produced in the reaction. The experimental setup should include apparatus that allows for the precise collection and measurement of the gas.

- (ii) Make sure that the mass of each sample used for both experiments are equal, and that the same amount of hydrochloric acid used is the same.

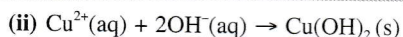
EXAM TIP:

To ensure a fair experiment, think of the parameters that should be kept constant so that the amount of copper(II) carbonate in the copper ore sample is the only manipulated variable.

- (b) (i) test Add dilute NaOH(aq).
result A light blue precipitate forms.
The precipitate does not dissolve upon adding excess NaOH(aq).

EXAM TIP:

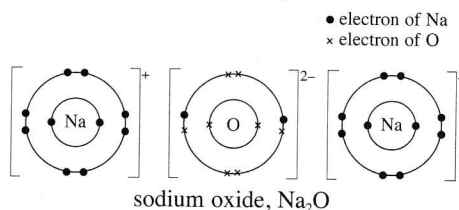
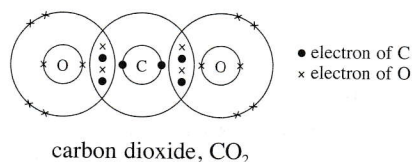
The reagent that can be used to test for the presence of copper(II) ions in a solution is aqueous sodium hydroxide or aqueous ammonia.



Section B

8. (a) Neutral oxide and amphoteric oxide

- (b) (i)



- (ii) Sodium oxide is an ionic compound. Its ions are held together by strong electrostatic forces of attraction, forming a giant ionic lattice. A lot of energy is required to overcome these strong electrostatic forces, hence sodium oxide has a very high melting point that is above room temperature. Carbon dioxide however, is a simple covalent molecule. Little energy is required to overcome the weak intermolecular forces of attraction between the small carbon dioxide molecules, hence carbon dioxide has a very low melting point that is below room temperature.

EXAM TIP:

The C and O atoms of carbon dioxide are bonded by covalent bonds. The Na⁺ and O²⁻ ions of sodium oxide are bonded by ionic bonds.

9. (a) They are good conductors of electricity and are malleable.
- (b) (i) When water is hot, the water molecules have greater kinetic energy and can collide with the metal more frequently. This increases the frequency of effective collisions, resulting in a higher rate of reaction.
- (ii) When the metal is powdered, a greater surface area is exposed, allowing for water molecules to collide at more places. As a result, the frequency of effective collisions increases, leading to a higher rate of reaction.
- (c) (i) Metal **G** is low in the reactivity series (relatively unreactive) and will not react with water at all.
- (ii) Metal **H** is a reactive metal while metal **G** is an unreactive metal. Compounds of **H** are more stable than compounds of **G**, so more energy is needed to extract metal **H** from its compounds than extracting metal **G**.

EXAM TIP:

The reactivity of a metal affects how vigorous a reaction is.

- (d) G: copper
H: sodium

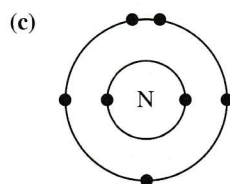
10. (a) Relative atomic mass refers to the average mass of an atom compared with $\frac{1}{12}$ of the mass of a carbon-12 atom.

- (b) (i) Isotopes
(ii) Nitrogen atoms can exist as isotopes, which have the same proton number but different nucleon number.

However, all nitrogen atoms have 5 valence electrons, regardless of nucleon number, and will have the same chemical properties.

EXAM TIP:

The chemical properties are governed by the number of valence electrons in an element.



EXAM TIP:

A nitrogen atom has 7 electrons.

- (d) (i) Number of moles of $N_2 = \frac{56}{28}$
 $= 2 \text{ mol}$

Since 1 mole of N_2 reacts to form 2 moles of NH_3 ,

$$\text{number of moles of } NH_3 \text{ produced} = 2 \times 2 = 4 \text{ mol}$$

$$\begin{aligned} \text{Mass of ammonia formed} \\ &= 4 \times (14 + 1 + 1 + 1) \\ &= 68 \text{ g} \end{aligned}$$

EXAM TIP:

$$\text{Number of moles} = \frac{\text{Mass}}{\text{Molar mass}}$$

$$\text{Mass} = \text{Number of moles} \times \text{Molar mass}$$

- (ii) Volume of ammonia $= 4 \times 24$
 $= 96 \text{ dm}^3$

EXAM TIP:

$$\text{Volume (dm}^3\text{)} = \text{number of moles} \times \text{molar volume}$$

Multiple Choice Questions

21. (B)

Comparing the distances that each spot travelled, we find that the spots travel 4 different distances. This means that there are 4 different dyes in the five inks.

EXAM TIP:

In the same chromatogram,

- different dyes travel different distances;
- identical dyes travel the same distance.

22. (D)

X is not ammonium chloride as it does not produce ammonia when heated with sodium hydroxide, indicating that ammonium ions are not present. X is not magnesium since it is not a silvery solid. It is not certain if X is acidic as it is not known if X reacted with sodium hydroxide. While the red litmus paper does not change colour, it can only be certain that no basic gas was evolved. The lack of colour change of red litmus paper could be due to other factors.

EXAM TIP:

We add aqueous sodium hydroxide to the test result, and warm the mixture, to identify the aqueous cation; we add aluminium to the test result to identify the anion; and observe the colour change of the litmus paper to identify the nature of the gas.

23. (A)

Particles in liquids and gases are arranged randomly. Substances B, C and D are in solid state at room temperature. Since substance A boils at -80°C , it exists as a gas at room temperature.

EXAM TIP:

Find which substance boils at temperatures lower than room temperature. Room temperature can be taken to be 25°C .

24. (C)

The atom has 5 protons and 7 neutrons. Hence it has a nucleon number of 12 and a proton number of 5. Atoms of different elements each have a specific number of protons. Based on the Periodic Table, the atom is $^{12}_5\text{B}$. Carbon has 6 protons.

EXAM TIP:

Determine the atom by counting the number of electrons, neutrons and protons.

25. (C)

Ionic compounds conduct electricity in molten and aqueous states but not in solid state.

EXAM TIP:

In molten and aqueous states, ions in the ionic compound are free to move, thus can conduct electricity. However, in solid state, there are no mobile ions, thus the ionic compound cannot conduct electricity.